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In re Patent Application of
PTASINSKI et al
Serial No. 09/490,116
Filed: January 24, 2000

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Group: 2749
Examiner: Unknown

For: A Portable Multi-Band Communication Device, and A Method For Determining A Charge Consumption Thereof

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Honorable Assistant Commissioner of Patents
Washington, DC 20231

SUBMISSION OF PRIORITY DOCUMENTS

Sir:

It is respectfully requested that this application be given the benefit of the foreign filing date under the provisions of 35 U.S.C. §119 of the following, a certified copy of which is submitted herewith:

Application No.	Country of Origin	Filed
9900270-1	Sweden	27 January 1999
9902625-4	Sweden	8 July 1999

Respectfully submitted,
NIXON & VANDERHYE P.C.

April 5, 2000

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PRV

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Patentavdelningen

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Intyg
Certificate

Härmed intygas att bifogade kopior överensstämmer med de handlingar som ursprungligen ingivits till Patent- och registreringsverket i nedannämnda ansökan.

This is to certify that the annexed is a true copy of the documents as originally filed with the Patent- and Registration Office in connection with the following patent application.

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För Patent- och registreringsverket
For the Patent- and Registration Office

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A PORTABLE MULTI-BAND COMMUNICATION DEVICE

BACKGROUND

Cellular phone production.
Estimation of remaining capacity in the battery.

PROBLEM

Users of cellular phones become more and more dependent of a fully functional bettery driven system. They need to know exactly for how long their phones will remain functional. This requires a well functioning, accurate fuel gauge. Several solutions have been proposed;

One solution is disclosed in the Swedish patent application entitled "A portable communication device and a method for determining the power consumption thereof", which was filed together with this application by the present applicant and is fully incorporated therein by reference.

. As far as we know there is no solution that deals with the problem of multiple bands. Traditionally, each frequency band would require a separate set or table of current-consumption values. This approach is very memory inefficient. Our solution deals with multiple bands and minimizes the memory needs at the same time.

SOLUTION

Our solution is based on the solution disclosed in aforesaid patent application, but applied to a multi-band communication apparatus.

When a TX strobe occurs a burst has to be transmitted at correct output power, which depends on the frequency band that is used. Correct output power is obtained by regulating the analog input signal to the power amplifier module (PA). The software in the phone calculates a proper hexadecimal value to be D/A converted (DAC value) and used as input signal to the PA. Independently of the signalling band the mentioned transmitting procedure concludes in a calculated DAC value. This procedure must be followed regardless of whether fuel gauging is used or not. In our solution, the DAC value can be used for fuel gauging purposes.

Several approaches are possible:

A)

Each hexadecimal DAC value corresponds to a certain current consumption in the PA module independently of the signalling band. This DAC value is used as index in a

table of TX strobe counters. Each time a counter is indexed it will be increased. Each level in this table corresponds to a certain PA current consumption. Each time an estimation of the power consumption is needed each counter will be multiplied by the corresponding current consumption value. This leads to a value of the total current consumption. Since the duration of a TX burst, and thus the duration of the current consumption, is well defined the power consumption can be calculated by multiplying the total current consumption previously calculated with the TX burst time. The calculated power consumption can now be used in further calculations when estimating the remaining capacity of the battery.

B)
It is more memory efficient to use one counter rather than a table of counters. This counter will be incremented with the PA current consumption value corresponding to the calculated DAC value for each TX burst. The gain is that there is no longer a need for a table of counters (memory efficiency) and no table multiplication needs to be performed (CPU power efficiency).

C)
The table(s) in the solution mentioned above can be quite memory consuming. The size of the table(s) can be reduced with no, or very little, loss in accuracy by having fewer levels and using interpolation to obtain the correct current-consumption value. The same counter as in B) above is used but the PA current-consumption table is reduced in size. In this case each level in the table can be thought of as a boundary. To obtain the same accuracy as in case A) an interpolation based on the DAC value and the nearest boundary values is performed.

D)
The current-consumption table mentioned in the cases above can be replaced by a polynomial, i.e. current as a function of the DAC value, for further memory efficiency.

E)
In all cases above the multiplication with time can be incorporated in the values stored in the table or performed when the counter is increased, thus giving a power consumption counter on the fly.

MERITS OF INVENTION

Band independent fuel gauge apparatus.
Multiband compatible fuel gauge apparatus.
Improved accuracy compared to prior art.
RAM efficient solution since tables can be replaced by polynomials.
Virtual tables by interpolation between fixed levels.
Dynamic estimation of power consumption.

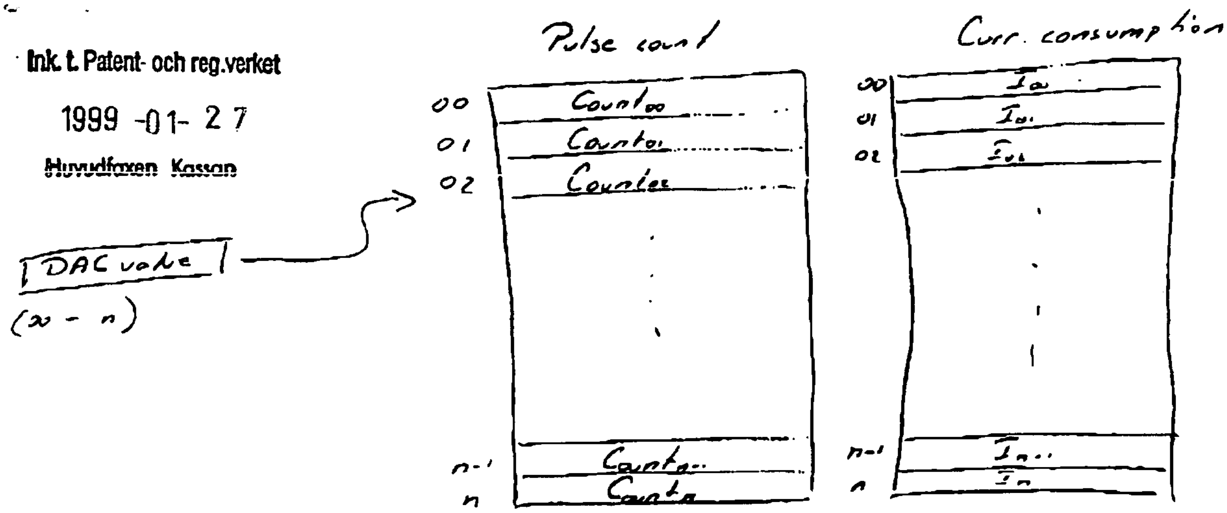
CLAIMS

1. A portable multi-band communication device, comprising a power amplifier, a battery for supplying power to the power amplifier, a controller, a D/A (digital-to-analog) converter and a memory, the controller being arranged to control the power amplifier by providing a digital control signal to the D/A converter, which supplies an analog output signal to the power amplifier,
characterized by
means for determining a value representing the consumption of electric energy from the battery by using said digital control signal.

ABSTRACT

1. A portable multi-band communication device has a power amplifier, a battery for supplying power to the power amplifier, a controller, a D/A (digital-to-analog) converter and a memory. The controller controls the power amplifier by providing a digital control signal to the D/A converter, which supplies an analog output signal to the power amplifier. Means are provided for determining a value representing the consumption of electric energy from the battery by using said digital control signal.

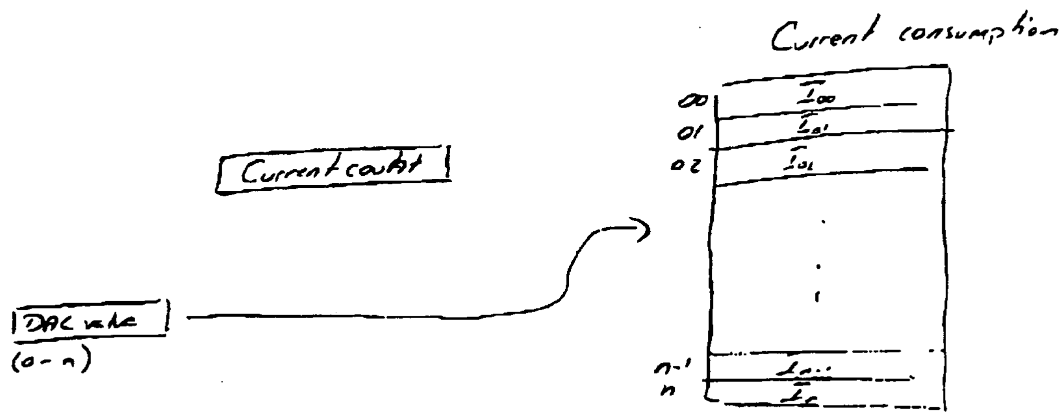
To be published together with FIG 1.



TX burst ⇒ DAC value calculated ⇒ $Count_{DAC\,value}$ increased

Power consumption = $t_{TXburst} \cdot \sum Count_i \cdot I_i$ $\quad i = 0 - n$

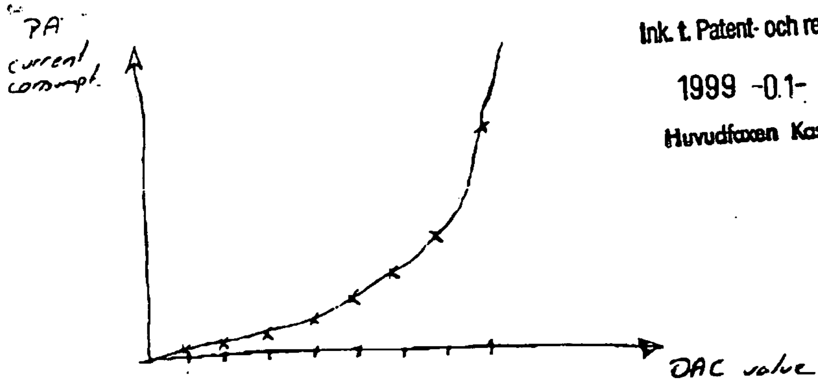
Figure 1: Solution (A)



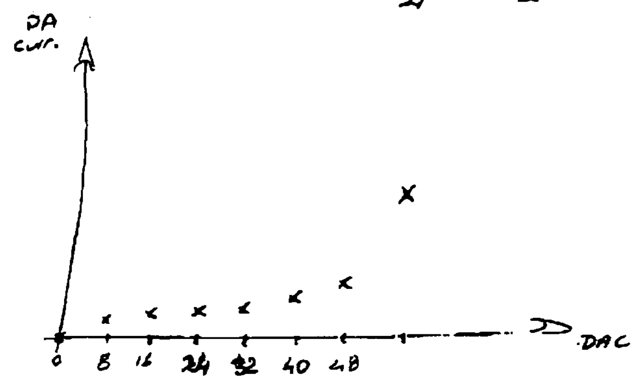
TX burst ⇒ DAC value calculated ⇒ Current count = Current count + $Currentconsumpt._{DAC\,val.}$

Power consumption = $t_{TX} \cdot$ Current count

Figure 2: Solution (B)



Assume that we store only every eight value:



We create a table:

idx = DAC value modulus 8

$m = n_{(\max DAC\ value)}$ modulus 8

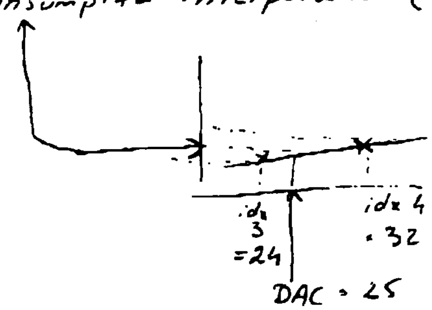
PA current consumpt.

idx	
0	I_0
1	I_1
2	I_2
.	
.	
.	
m-1	I_{m-1}
m	I_m

Example:

DAC value: 25 ⇒ idx = 25 mod 8 = 3 rest = 1

Current consumpt = Interpolation ($PA\ curr\ cons_3$, DAC value, $PA\ curr\ cons_4$)



⇒ Power consumpt = t_{TX} · Current cons.

Fig 3. Solution (C)